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ABSTRACT

A motor performance typology of boys and girls (ages 6-10 years) was developed, based on four factors extracted by factor analysis from data on 47 physical growth and motor performance variables. Nineteen variables which best described the four factor-defined components were used in formulating the person-clusters (typologies) following Tryon's Condensation Method. Eleven person-clusters emerged, which included 137 of the 146 children tested, or 95 percent of the group. The five person-clusters that accounted for the majority of girls (73 percent) accounted for only 16 percent of the boys. The six person-clusters that accounted for the majority of boys (84 percent) accounted for only 27 percent of the girls. (Author)

A Motor Performance Typology of Boys and Girls in the Age Range 6 to 10 Years

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The belief that man's motor performance capabilities are dependent on a single unitary ability has long since been dispelled. While it has been well established that there is marked specificity in the performance of both fine and gross motor responses, there is nevertheless substantial evidence, based on a number of factor analytic studies, to indicate that there are basic components or general factors upon which specific motor abilities depend. (Cumbee, 1954: Fleishman, 1964; Jackson, 1971; Larson, 1941; McCloy, 1956; and Rarick, 1937).

An approach currently little used in our field, but one which provides a meaningful way of examining behavioral differences in humans is a methodology designed to identify person-clusters, i.e., individuals who show similarity in a number of specified traits. Essentially, this procedure involves the grouping of persons who are similar in respect to patterns of traits or abilities as evidenced by a profile similarity. This procedure proposed by Stephenson (1950, 1952) is a means of developing typologies which involve determining the relationship among people on a number of abilities rather than correlating abilities within a group of people. The rationale for this approach is that given a broad array of data on a sample of people, it is just as important to see how similar or how different these people are on clusters of traits as it is to see how these characteristics themselves relate to each other. Recognition of the

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significance of identifying "types" of individuals who have similar configurations of abilities has led to a variety of procedures for profile construction and for the assessment of similarities and differences between profiles (Cronbach and Gleser, 1953).

The purpose of the present investigation was to construct and describe a motor performance typology of a group of young boys and girls based on four basic components derived from a factor analysis of 47 tests of fine and gross motor performance believed to encompass a major segment of these children's motor domain.

Procedures

Sample: Seventy-one boys and 74 girls in the age range 6 to 9.9 years, all pupils in one suburban elementary school in the San Francisco-East Bay region, constituted the sample for the investigation. The mean chronological age of the boys was 100.7±13.6 months; that of the girls 102.8±13.5 months.

Source of Data: The data for the analysis came from a factor analytic study (Rarick and Dobbins, 1972) in which a total of 47 tests provided the basic data for the factor analysis. The analysis yielded eight factors for the boys and ten factors for the girls. Subsequent analyses utilizing eight factor solutions, (four orthogonal and four oblique) identified four comparable common factors and three comparable specific factors for the boys and five comparable common factors and three comparable specific factors for the girls. (Rarick and Dobbins, 1974). The four factors which accounted for the major proportion of the variance together with the descriptor variables that yielded highest loadings on the respective factors are shown in Table 1. It is upon these four factors, labelled 1) strength-power-body size; 2) gross body coordination; 3) fine motor skills; and 4) balance that the present study is based. In view of the possible confounding effect of age (moderate correlations between C.A. and performance scores) each subject's raw score on each variable was adjusted to a common age of 100 months by means of the method of least squares. It was these adjusted or predicted scores that were used in the computations.

The procedure that was followed in developing the person-clusters (object clusters) was the methodology developed by Tryon (1967), known as the Condensation Method. The result of this analysis is to place within each cluster persons with similar performance profiles. The first step in this procedure is to calculate standard scores for each subject on each test in each of the four specified components of the motor domain. Each subject's standard scores on a given component are then summed and the sums of these scores likewise converted to standard scores (mean of 50, S.D. of 10). In this instance each individual had four standard scores, one for each of the four components. These scores constituted an orthogonal Cartesian space of four dimensions.

The above approach utilizing an equal weighting of definers is recommended by Tryon and Bailey (1970). While predicted weights based on the correlations between the definers and the dimension (factors) may be calculated, or factor loadings themselves may be used as weights, equal weighting for definers is easier to interpret and perhaps most meaningful. Support for this comes from Dagenais and Marascuilo (1973) who reported no significant differences between the resultant weighted scores when raw scores were weighted by Guttman scores, factor loadings, or by the method of equal definer weighting.

A second step in person clustering is to assign subjects temporarily into appropriate Core O-types (subject types). The number of O-types is determined by an arbitrary sectioning of the cluster score space. In the present investigation a cluster score space of 81 sectors (3^4) was arbitrarily chosen, the number of sectors in this case being dependent on the number of dimensions (four) and the number of categories (three) per dimension. While there is no set standard for defining the limits of each category, the cut-off points in this investigation were arbitrarily set at ± 1 S.D. On the Z-scale this gave the following three categories with their respective limits: High, above 60; Middle, 40 to 60; and Low, below 40. Thus, subjects with Z-scores in all four dimensions higher than 60 were temporarily assigned to the highest Core O-type (HHHH), whereas those with Z-scores in all four dimensions below 40 were temporarily assigned to the lowest Core O-type (LLLL). Those subjects with Z-scores on all four dimensions within the range of 40 to 60 were placed temporarily in the middle category (MMMM). The other subjects were appropriately assigned to categories between the very highest and the lowest according to their respective Z-scores on the four dimensions. Clearly, most subjects would not fall within these three well-defined categories since a given subject's Z-scores might place him high in one or more of the four dimensions and in the middle or low category in the others. Theoretically, the 145 subjects in this investigation could have been distributed among the 81 sectors on the initial casting. In this instance the 145 subjects initially fell into 16 sectors of the score space as defined by the limits of the score patterns previously specified (various combinations of HML categories). Thus, there were initially 16 Core O-types.

A third step is to designate with one value the Euclidean Distance D between the centroids of each core O-type. Based then on the researcher's decision regarding the final number of person types (eleven) and/or the minimum number of persons per person-cluster (seven), the core O-types were collapsed to the designated number by the successive combination of O-types with the smallest Euclidean distances.

The Condensation Method (the fourth step), an integral part of O-Analysis, reduces the heterogeneity within the several O-types by retaining or reassigning subjects on the basis of the criterion Root Mean Square (RMS). The criterion set here for inclusion within an O-type was arbitrarily set at a RMS of 10 or less. The RMS is the square root of the sum of the squared deviations of the individual's standard scores from those of the O-type to which he is compared, divided by the number of dimensions --- four in this case. To illustrate, Table 2 shows the procedure that was used in calculating the Root Mean Square for two subjects given their respective mean Z-scores on each of the four components and similarly the Z-scores of the reference O-type. On this basis Subject A with a RMS of .9126 was retained in the parent O-type whereas Subject B (RMS 10.763) was rejected to be reassigned to another O-type on the basis of the criterion previously specified. If the subject failed to meet this criterion with reference to any O-type, the subject was then identified as unique. The above procedure was followed through repea d iterations until there was no reassignment of subjects in two successive iterations.

Results and Discussion

Eleven typologies or person-clusters emerged from the analysis. As may be noted in Table 3 this included 67 of the 71 boys and 70 of the 74 girls, or 94 per cent of all subjects. A graphic description (means and standard deviations) of the motor performance typologies of the eleven person-clusters is shown in Figure 1, including the number of boys and girls in each. The differences in the person-clusters are clearly evident by visual inspection.

For convenience of examination, the clusters are ordered from one to eleven in descending order of performance excellence. Type 1 includes subjects with all four components above the mean, Type 11 those with all four below the mean. Both types 1 and 11 have twice as many boys as girls. It is interesting that Type 11 includes more than twice as many boys as girls in view of the many studies that have shown that boys in this age range generally outperform girls on most gross motor tasks, except those requiring balance. Some 19 per cent of the boys and girls that were typed fell within these two extreme categories. For the most part the types with high mean values on the strength-power component are rather heavily populated with boys (Types 5, 7 and 9), whereas those with high mean scores on fine motor coordination and balance and low means on strength-power have a high concentration of girls (Types 3 and 6). Type 4 (9 girls and 1 boy) is an interesting type having high mean scores on components of strength-power, fine motor coordination, and balance, but scores slightly below the mean on gross body coordination.

It is evident from the typologies developed here that not many children were good in all of the components that were assessed (6.5%) and similarly not many were poor in all (12.4%). The five person-clusters that accounted for the majority of girls (73%) included only 16% of the boys.

The six person-clusters that accounted for the majority of boys (84%) accounted for only 27% of the girls. Thus, while it is evident from the distribution of numbers of children by sex within the several types that there was a substantial difference in the motor performance typology of young boys and girls, there was only one of the 11 types (Type 7) which did not include children of both sexes.

Table 1. The Factor-Defined Components of the Motor Domain and the Variables That Best Describe These Factors

Factor 1. Strength-Power-Body Size

- Height
- Weight
- Grip Dynamometer Strength (Right)
- Grip Dynamometer Strength (Left)
- Bicycle Ergometer No. Rev. in 90 Sec (Res. = 1.5 kp)

Factor 2. Gross Body Coordination

- Vertical Jump
- 35 Yard Dash
- Standing Broad Jump
- Scramble
- 150 Yard Run

Factor 3. Fine Motor Abilities

- Adapted Minnesota Manipulative
- Purdue Pegboard
- 2-Plate Tapping Test
- Ring Stacking Test
- Golf Ball Transfer Test

Factor 4. Balance

- Railwalk Forward
- Railwalk Backward
- Railwalk Sideways
- Stork Stand

TABLE 2 Example of the Procedure Used in Determining the Root Mean Square (RMS) Between An O-type and the Cluster Scores of Two Individuals

	Component 1 (Str.-Power-Body Size)	Component 2 (Gross Motor Coor.)	Component 3 (Fine Motor Ab.)	Component 4 (Balance)
O-type Means	36.6680	40.9709	43.7059	41.7527
Raw Scores				
Z-Scores, Subject A	36.1994	42.5272	46.0145	44.0530
Z-Scores, Subject B	15.2713	49.2131	16.0770	17.9953
Deviation from Means				
Subject A	- .4686	1.5563	2.3086	2.3003
Subject B	-21.3967	8.2422	-27.6289	-23.7574
(Deviation from Means)^2				
Subject A	.2196	2.4220	5.3926	5.2913
Subject B	457.8188	67.9338	763.3561	564.4141

$\sqrt{\Sigma(\text{Deviation from Means})^2}$

Subject A = 3.6504

Subject B = 43.0526

$\text{RMS} = \sqrt{\Sigma(\text{Deviation from Means})^2/k}$

Subject A = .9126

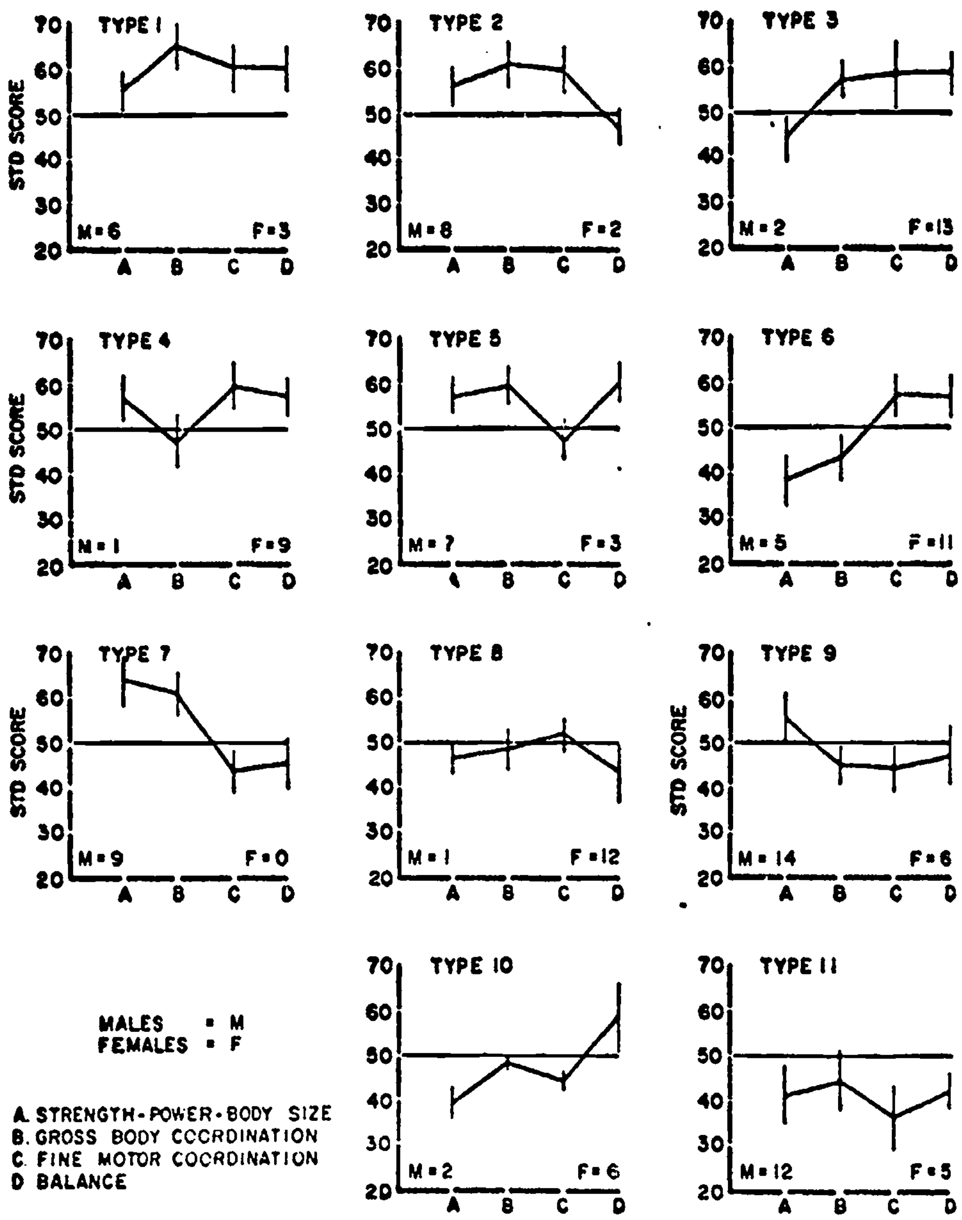
Subject B = 10.7632

Table 3. Number and Percentage of Boys and Girls Grouped According to Person-Clusters

Person-Cluster	Males		Females		Total
	No.	Percent	No.	Percent	
1	6	8.9	3	4.3	6.5
2	8	11.9	2	2.8	7.4
3	2	2.9	13	18.6	10.9
4	1	1.5	9	12.9	7.4
5	7	10.4	3	4.3	7.4
6	5	7.5	11	15.7	11.6
7	9	13.4	0	0.0	6.5
8	1	1.5	12	17.1	9.4
9	14	20.9	6	8.6	14.5
10	2	2.9	6	8.6	5.8
11	12	17.9	5	7.1	12.4

Figure Title

1. Profiles in Standard Scores of Boys and Girls on Four Components of Motor Performance



TYPE 1
M=6 F=3
TYPE 2
M=8 F=2
TYPE 3
M=2 F=13
TYPE 4
M=1 F=9
TYPE 5
M=7 F=3
TYPE 6
M=5 F=11
TYPE 7
M=9 F=0
TYPE 8
M=1 F=12
TYPE 9
M=14 F=6
TYPE 10
M=2 F=6
TYPE 11
M=12 F=5
STD SCORE
MALES = M
FEMALES = F
A. STRENGTH-POWER-BODY SIZE
B. GROSS BODY COORDINATION
C. FINE MOTOR COORDINATION
D. BALANCE

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